H-493

THE

HICKOK

ELECTRICAL
INSTRUMENT
COMPANY

OPERATING INSTRUCTIONS

Cathode Ray Oscilloscope

Model 770

CHOICE OF THE EXPERTS
FOR SPEED, ACCURACY
and DEPENDABILITY...

OPERATING INSTRUCTIONS

for

Model 770

Cathode Ray Oscilloscope

THE HICKOK ELECTRICAL INSTRUMENT COMPANY

10514 Dupont Avenue • Cleveland 8, Ohio

TABLE OF CONTENTS

PARAGRAPH	TITLE	PAGE
	SECTION 1 - DESCRIPTION	
1.1	Purpose	1
1.2	Description	1
	SECTION 2 - THEORY	
2.1	General	1
2.2	Cathode Ray Tube	1
2.3	Power Supply	1
2.4	Vertical Amplifier	3
2.5	Horizontal Amplifier	3
2.6	Sync. Amplifier	3
2.7	Time Base Generator	3
2.8	Blanking Amplifier	4
	SECTION 3 - OPERATION	
3.1	General	4
3.2	Controls and Their Functions	4
3.3	Cautions	6
3.4	Precautions	6
3.5	Preliminary Operation	6
	SECTION 4 - APPLICATION	
4.1	General	7
4.2	Observation of Waveforms	7
4.3	Measurement of Peak-to-Peak Voltages	7
4.4	Measurement of Frequency Using Lissajou's Figures	8
4.5	Visual Alignment of FM and TV Receivers	8
	SECTION 5 - MAINTENANCE	
5.1	General	9
5.2	Fuse	9
5.3	Vacuum Tubes	9
5.4	Cathode Ray Tube	9
5.5	Adjustments	9

LIST OF ILLUSTRATIONS

FIGURE	TITLE	PAGE
1.1	Model 770 Cathode Ray Oscilloscope	v
2.1	Basic Circuits in Block Form	2
4.1-4.2	Waveforms	7
4.3, 4.4 & 4.5	Lissajou's Figures	8
5.1	Chassis View, Model 770	11
5.2	Trouble Shooting Chart	12
5.3	Vacuum Tube Voltage and Resistance Data Chart	13
6.1	Parts List	17
6.2	Schematic Wiring Diagram	Inside Back Cover

TECHNICAL DATA SHEET

EQUIPMENT SUPPLIED

(ONE COMPLETE UNIT)

QUAN.	NAME	STYLE	STOCK NO.	DIMENSIONS	WEIGHT
1	Oscilloscope	770	902-255	12" x 14" x 18"	50 lbs.
1	Instruction Book		2490-264	8-1/2" x 11"	
1	Test Lead--Gnd.		12450-225	48"	
1	Test Lead, shielded		3030-58	48"	

TECHNICAL CHARACTERISTICS

1. POWER SUPPLY REQUIRED: 105-125 V, 50-400 cycles, AC.

2. POWER CONSUMPTION: 135 watts at 115 volts. (Fused 1.5 AMP.)

3. DEFLECTION SENSITIVITY:
   (a) 1st Vertical Amplifier: .010 volts RMS/inch, with Band Width switch in narrow position.
   2nd Vertical Amplifier: .035 volts RMS/inch, with Band Width switch in wide position.

   (b) Vertical Direct: 13 volts RMS/inch

   (c) Horizontal Amplifier: .075 volts RMS/inch

   (d) Horizontal Direct: 17 volts RMS/inch

4. INPUT IMPEDANCE:
   (a) Vertical Amplifier: 2.2 meg, 50 mmf.

   (b) Vertical Direct, Unbalanced: 2.2 meg, 20 mmf.
   Vertical Direct, Balanced: 4.4 meg, 20 mmf.

   (c) Horizontal Amplifier: 2.2 meg, 50 mmf.
   Horizontal Direct, Unbalanced: 2.2 meg, 20 mmf.
   Horizontal Direct, Balanced: 4.4 meg, 20 mmf.

5. MAX. AC-RMS INPUT VOLTAGE OF VERT. STEP ATTENUATOR:
   (a) X1 - 1 volt rms
   (b) X10 - 10 volts rms
   (c) X100 - 100 volts rms
   (d) X1000 - 1000 volts rms

6. FREQUENCY RANGE:
   (a) 1st Vertical Amplifier: 0-2.5 mc. (3 db) with Band Width switch in narrow position.
   2nd Vertical Amplifier: 0-5 mc. (3 db) with Band Width switch in wide position.

   (b) Horizontal Amplifier: 0-500 kc., (3 db)

7. RECURRENT & DRIVEN SWEEP LINEAR TIME BASE:

   Gas Triode, Type 884
   Frequency Range: 2 cycles to 30 kc per second. Slower sweep speeds, connecting external capacity to horizontal DC input binding post and GND.
   Time Duration (Driven Sweep): 0.5 seconds to 30 microseconds.

8. EXPANDABLE SWEEP TO 6 TIMES FULL SCREEN--Positioning circuit may be adjusted so that any portion of the sweep can be seen.

9. Z AXIS MODULATION CIRCUIT: (a) Input Impedance: .2 meg, 80 mmf.
   (b) Sensitivity: 2 V peak-to-peak to blank out the beam depending on intensity setting.

TECHNICAL DATA SHEET

EQUIPMENT SUPPLIED

(Concluded)

10. TEST SIGNALS:

(a) Line Freq. test signal of 3 volts RMS at power line frequency is available from the front panel binding post.

(b) Sawtooth test signal of 7 volts peak-to-peak is available from the front panel binding post.

11. TUBE COMPLEMENT:

REF. SYMBOL	TYPE	FUNCTION
V101	12AU7	Horizontal Input Cathode Follower
V102	6J6	Horizontal Input Amplifier
V103	6J6	Horizontal Output Amplifier
V104A	½12AU7	Blanking Amplifier
V104B	½12AU7	Sweep Cathode Follower
V105A	½6AL5	Driven Sweep Clamper
V105B	½6AL5	Sync. Limiter
V106A	½12AU7	Regulator
V106B	½12AU7	Internal Sync. Amplifier
V107	884	Sweep Discharge Tube
V108	12AU7	Vert. Input Cathode Follower
V109	12BH7	Vertical Input Amplifier
V110	12AV7	Vertical Transition Amplifier
V111	12AV7	Vertical Intermediate Cathode Follower
V112	6CL6	Vertical Output Amplifier
V113	6CL6	Vertical Output Amplifier
V114	12AU7	Phase Splitter & Sync. Amplifier
V115	5Y3	Low Voltage Rectifier
V116	1X2B	Negative High Voltage Rectifier
V117	1X2B	Positive High Voltage Rectifier
V118	OB2	105V Regulator
V119	5ABP1*	Cathode Ray Tube

*NOTE: Either the type 5ABP7 or 5ABP11 cathode ray tube may be ordered in place of the 5ABP1 which is supplied in the standard Model 770 instrument as these tubes are completely mechanically and electrically interchangeable. This will, of course, result in a slight increase in cost.

12. CALIBRATION VOLTAGE, PEAK-TO-PEAK: .1 - 1 - 10 - 100 volts.

13. PHASING CONTROL: ± 90°.

STANDARD RETMA GUARANTEE

The Hickok Electrical Instrument Company warrants instruments manufactured by it to be free from defective material or factory workmanship and agrees to repair such instruments which under normal use and service, discloses the defect to be the fault of our manufacturing. Our obligation under this warranty is limited to repairing any instrument or test equipment which proves to be defective, when returned to us, transportation prepaid, within ninety (90) days from the date of original purchase and provided the serial number has been made known to us promptly for our records.

This warranty does not apply to any of our products which have been repaired or altered by unauthorized persons or service stations in any way so as, in our judgment, to injure their stability or reliability or which have been subject to misuse, negligence, or accident, or which have had the serial number altered, effaced, or removed. Neither does this warranty apply to any of our products which have been connected, installed, or adjusted otherwise than in accordance with the instructions furnished by us. Accessories including all vacuum tubes not of our manufacture used in this product are not covered by this warranty.

This warranty is in lieu of all other warranties expressed or implied and no representatives or person is authorized to assume for us any other liability in connection with the sale of our products.

Parts will be made available for a minimum period of five (5) years after the manufacture of this equipment has been discontinued. Parts include all materials, charts, instructions, diagrams, accessories, etc, which have been furnished in the standard model.

RETURNING EQUIPMENT FOR REPAIR

Before returning any equipment for service, under warranty or otherwise, the factory must first be contacted giving the nature of the trouble. Instructions will then be given for either correcting the trouble or returning the equipment. Upon authorization, this equipment should be forwarded directly to the Hickok factory address, 10636 Leuer Avenue, Cleveland, Ohio, or to a designated service station in your locality. All correspondence pertaining to repairs should be directed to the Hickok office address, 10514 Dupont Avenue. Cleveland 8, Ohio, or to the authorized service station designated.

REGISTRATION CARD

The above guarantee is contingent upon the attached registration card being returned to the factory immediately receipt of the equipment.

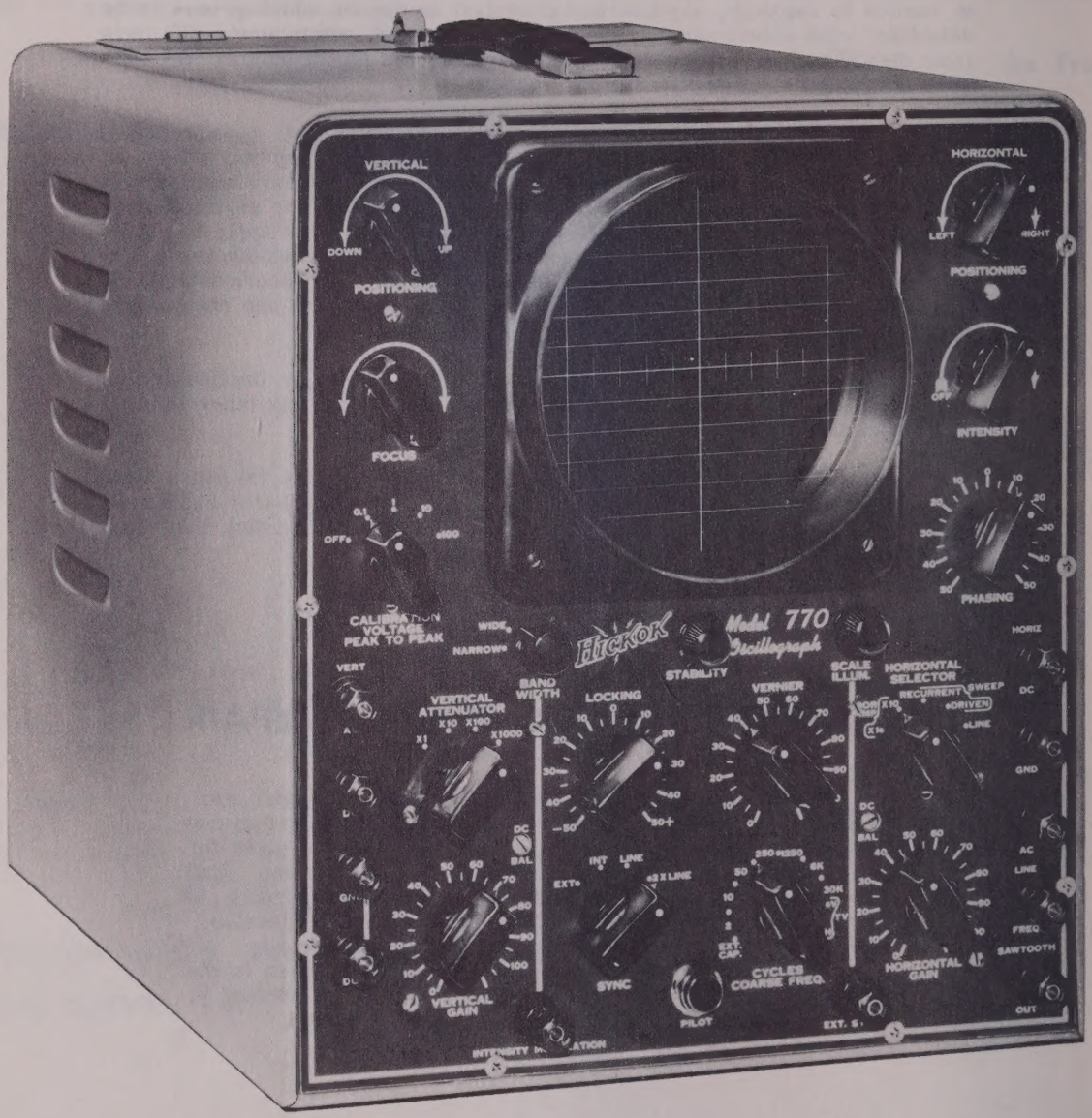


FIGURE 1.1 - MODEL 770 CATHODE RAY OSCILLOSCOPE

SECTION 1 - DESCRIPTION

1.1 PURPOSE

The Model 770 oscilloscope is a general purpose instrument which permits a complete visual analysis of electrical and electronic circuits. The effectiveness of a tube or circuit as an amplifier, rectifier or source of special wave shapes may be readily determined. Using Lissajou's figures, the oscilloscope provides a quick and easy method of determining unknown frequencies.

The Model 770 provides an accurate and versatile means of visually studying and interpreting electrical phenomena such as modulation, phase relations, voltage amplitudes, distortion, etc. Because of the design of the cathode ray tube and its associated circuits, the Model 770 will respond accurately to voltages in wide ranges of both frequencies and amplitudes. Permanent records may be made of any pattern, or series of patterns, by photography.

When used in conjunction with a source of frequency modulated radio frequency energy, the oscilloscope provides a means of visual alignment of television, amplitude and frequency modulated receivers.

1.2 DESCRIPTION

a. PHYSICAL

The Model 770, as shown in Figure 1.1, is a portable oscilloscope. The panel is of an etched aluminum finish with all switches, controls, and connectors clearly marked. The panel is divided functionally into three main sections: horizontal deflection, vertical deflection, and sweep circuit oscillator. The case is of steel with light grey baked lacquer finish and is furnished with a carrying handle and four blister feet.

b. FUNCTIONAL

The Model 770 will perform the following electrical functions:

(1) Provide a means of visually studying and interpreting electrical and magnetic phenomena.

(2) Permit the study and analysis of wave forms.

(3) Provide a means of measuring voltages and frequencies of AC signals.

(4) Permit visual testing and alignment of television, amplitude modulated and frequency modulated receivers, and electronic equipment when used in conjunction with sweep, amplitude, and frequency modulated generators.

(5) Permit measurement of hum, gain and distortion in audio amplifiers.

c. COMPONENTS

The AC power line cord is permanently attached. In addition, two test leads are furnished separately. One is a 48 inch unshielded test lead, black, with an alligator clip on one end and a spade clip on the other end. The other lead is a 48 inch shielded cable with an alligator clip on one end and two spade clips on the other end.

SECTION 2 - THEORY OF OPERATION

2.1 GENERAL

It is essential for proper operation of the Model 770 that the cathode ray tube be thoroughly understood. The interpretation of patterns obtainable has been left to Section 4, Applications, as constant reference is made to these patterns in that section.

2.2 CATHODE RAY TUBE

The cathode ray tube may be considered as having three basic parts: the electron gun, producing the electron beam; the defecting plates, controlling the direction of the electron beam; and the fluorescent screen for viewing the beam.

2.3 POWER SUPPLY

The conventional type of full wave rectifier power supply operates normally from a 105-125 volt, 50-400 cycle, AC source. Approximately 400 volts is developed from each side of the secondary to ground. All vacuum tubes are supplied from the filament which is center tapped, except the type 5Y3 low voltage rectifier, the two 1X2B high voltage rectifiers, and the 5ABP1 cathode ray tube. Approximately 400 volts DC with a current of 120 mils is used to supply the vacuum tubes.

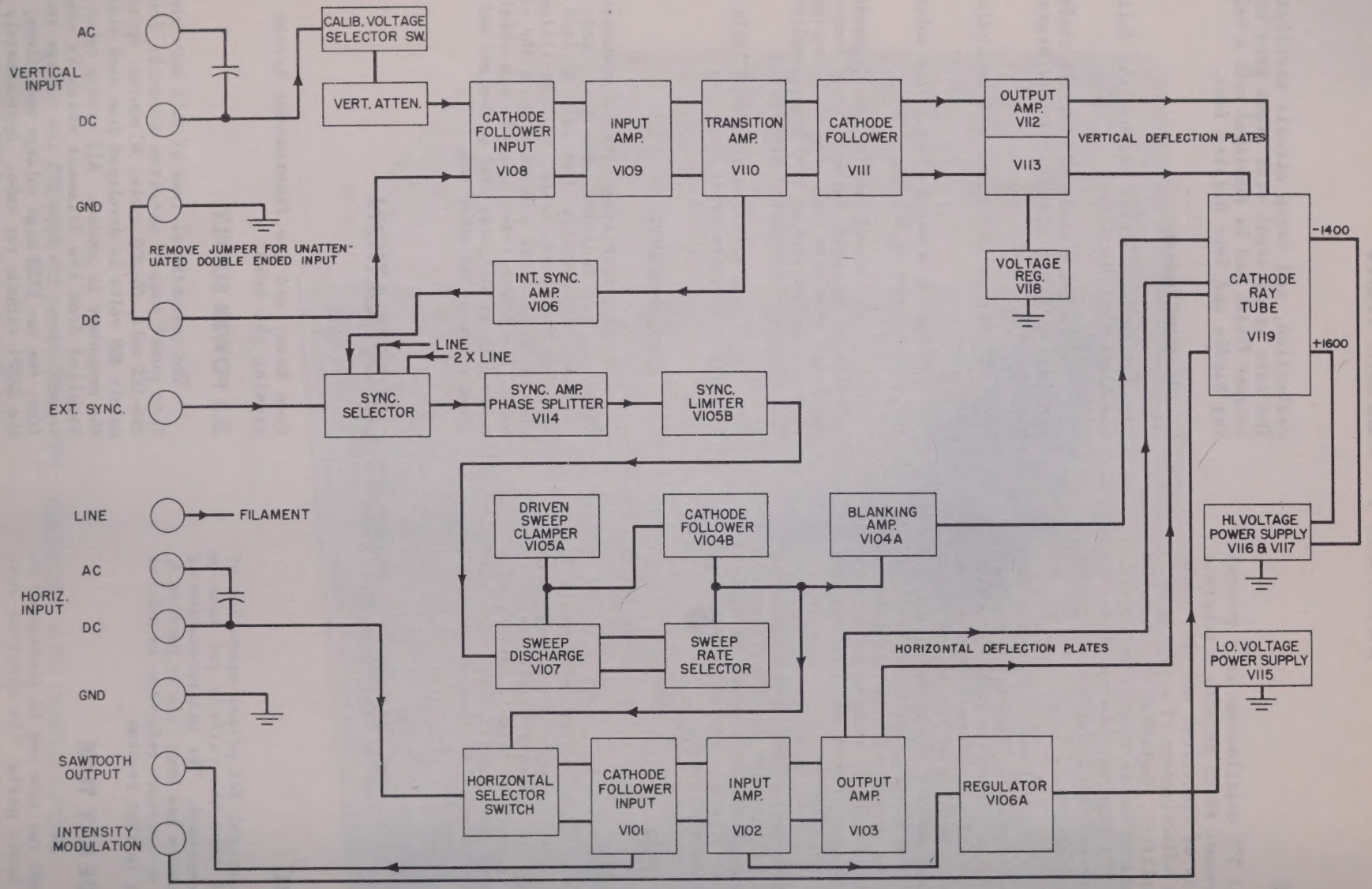


FIGURE 2.1 - BASIC CIRCUITS, IN BLOCK FORM

The high voltage (half-wave) power supplies are used to supply voltages to the cathode ray tube. Approximately 1300 volts is developed from the secondary of the transformer. This is impressed on the high voltage rectifiers, 1X2B's. Separate filament windings, 1.25 volts at .2 amps, are used for the high voltage rectifiers.

The -1400 volts DC which is applied to the cathode of the cathode ray tube together with the +1600 volts DC which is applied to the post accelerator provide a total accelerating potential of 3,000 volts DC for the cathode ray tube.

2.4 VERTICAL AMPLIFIER

The vertical amplifier consists of six tubes. The single ended input signal, AC or DC, is applied to a non-frequency discriminating attenuation network where the ratios are set by multiples of ten. This network feeds the active grid of a balanced cathode follower, V108. The inactive grid is brought out to a terminal on the front panel to make it available for non-attenuated double ended input, however, under normal single ended operation, this terminal is linked to the ground terminal. The gain control is a non-frequency discriminating type inserted between the cathodes of the cathode follower, V108. As the gain control is turned to zero, the cathodes of the cathode follower are shorted together through a small fixed resistor in series with the gain control which produces a ten-to-one attenuation. The action of the DC balance control is to bring the cathodes of the cathode follower to the same DC potential so there is no DC shift as the gain control is adjusted. The grids of the input amplifier, V109, are fed from the cathodes of the input cathode follower, V108. The grids of the transition amplifier, V110, are fed from the plates of the input amplifier, V109. The grids of the intermediate cathode follower, V111, are fed from the plates of the transition amplifier, V110. The relatively high capacity grids of the output amplifiers, V112 and V113, are fed from the low impedance cathodes of the intermediate cathode follower, V111. The vertical deflection plates of the cathode ray tube, V119, are directly connected to the plates of the output amplifiers, V112 and V113, through the removable jumpers on the direct connection board in the rear of the oscilloscope. In the wide position of the Band Width switch, S104, low frequency degeneration is introduced into the cathodes of the transition amplifier, V110, and the final amplifiers, V112 and V113. This low frequency degeneration together with cross neutralization applied to all the amplifiers to reduce their effective input capacities produces a uniform response to 5 mc at about 35 millivolts rms per inch deflection sensitivity. In the narrow position of the Band Width switch, S104, the low frequency degeneration is shorted out and the deflection sensitivity increases to 10 millivolts rms per inch with a band width of approximately 2.5 mc.

2.5 HORIZONTAL AMPLIFIER

The horizontal amplifier consists of three tubes. The HORIZONTAL SELECTOR switch, S101, has five positions: HOR. AMP. X1 or X10, RECURRENT or DRIVEN sweep, and phasing at LINE frequency. This switch is connected to the input tube, V101, which is a cathode follower. Both AC and DC potentials can be used. The two cathodes are balanced to zero by means of a potentiometer in one cathode. The HORIZONTAL GAIN control is between the two cathodes. Moving the HORIZONTAL GAIN control from zero to maximum will not shift the beam unless the cathodes are at different potentials. The BALANCE control can be readjusted to bring the cathodes at the same potentials. The center taps of the HORIZONTAL GAIN and HORIZONTAL POSITIONING controls are connected to the grids of the first horizontal push-pull amplifier, V102. The output voltages at the plates are in turn connected to the second horizontal push-pull amplifier, V103, and the output voltages at the plates of V103 excite the horizontal deflection plates of the cathode ray tube, V119, through the removable jumpers on the direct connection board in the rear of the oscilloscope.

2.6 SYNC. AMPLIFIER

The SYNC. selector switch, S105, consists of four positions: EXT., INT., LINE and 2X LINE frequency. On the INT. position, the sync signal is tapped off one of the plates of the transition amplifier, V110, through an isolation resistor to the grid of the internal sync amplifier, V106B, and then on to the sync selector switch. Voltages are fed to the input grid through a blocking capacitor of the sync. amplifier, V114, in any of the four positions. The cathode and anode of this amplifier are connected to a 200,000 ohm center tapped control, through blocking capacitors. The center tap is connected to ground and the movable arm is connected to the grid of the second amplifier. Moving the control clockwise or counterclockwise will determine the polarity of the input pulse or complex voltage. The plate of the second amplifier is fed to the grid of the type 884 tube, V107, through a blocking capacitor and the sync. signal on the grid is limited by a diode, V105B, to prevent distortion of the sweep.

2.7 TIME BASE GENERATOR

The circuit of the sawtooth generator consists of a gas triode, V107, type 884. This tube contains an inert gas. Ionization occurs when a certain voltage exists between the cathode and plate. This voltage is controlled by the bias voltage of the 884. The plate of

the gas triode is connected to the grid of a cathode follower, V104B. The output sawtooth voltage is taken from the cathode and fed to the horizontal amplifier through the HORIZ. SELECTOR SWITCH, S101.

When the cathode to grid bias of the gas triode is increased, ionization will occur at a higher plate potential. A diode, V105A, connected to the plate of the 884 is so biased that the gas triode potential on the plate can never get to the firing potential. This is driven sweep. If a positive voltage is fed to the input grid of the 884, ionization will occur because the grid to cathode bias is decreased and the firing potential is decreased.

A fine frequency control consists of potentiometer, R144, which changes the time constant and therefore changes the frequency.

The coarse frequency control is comprised of C114, C115, C116, C117, C118, and C119 switched by S102.

2.8 BLANKING AMPLIFIER

The blanking amplifier, V104A, input grid is connected to the cathode of the sawtooth cathode follower through a high frequency bypass. The return trace which is generally ten times the repetition rate is easily passed to the grid which in turn, causes amplification at the plate and is connected to the cathode ray tube, V119, to blank out the beam on the return trace.

SECTION 3 - OPERATION

3.1 GENERAL

This section on operation will serve the purpose of explaining the functioning of all controls and connectors on the front panel of the Model 770. Specific operating procedures will be given in Section 4, Application.

3.2 CONTROLS AND THEIR FUNCTIONS

a. CATHODE RAY TUBE CONTROLS

1. INTENSITY, R172: the extreme counterclockwise position of this control functions as the power on-off switch. After the power is on, it acts as a control of the intensity of the beam by controlling the Bias on the grid of the cathode ray tube.

2. FOCUS, R170: a control of the focusing of the cathode ray beam to produce a finely defined pattern.

3. SCALE ILLUMINATION, R202: a control of the illumination of the calibrated screen on the face of the cathode ray tube.

b. VERTICAL CONTROLS

1. VERTICAL ATTENUATOR, S103: a coarse control of the vertical input voltages to the vertical amplifier. There are four positions available:

(a) X1: the vertical input is fed directly to the cathode follower and vertical amplifier.

(b) X10: the input signal voltage is attenuated to 1/10th its normal value.

(c) X100: the input signal voltage is attenuated to 1/100th its normal value.

(d) X1000: the input signal voltage is attenuated to 1/1000th its normal value.

2. VERTICAL GAIN, R207: a vernier control of the voltages applied to the vertical input amplifier.

3. VERTICAL POSITIONING, R218, Down-Up: a control of the vertical position of the cathode ray pattern.

4. CALIBRATION VOLTAGE - PEAK TO PEAK, S103: a 5-position control providing for internal calibration voltages of .1 - 1 - 10 and 100. The OFF position connects the vertical DC and AC binding posts instead of the calibration voltage to the vertical attenuator.

5. BAND WIDTH, S104: a 2-position switch, when operated to the narrow position provides for a vertical sensitivity of 10 millivolts RMS per inch and frequency response to 2.5 MC, 3 DB. In the wide position, the vertical sensitivity is 35 millivolts RMS per inch with a frequency response to 5 mc, 3 DB.

6. DC BAL., R205: a control to bring the cathodes of the follower, V108, to the same potential. If necessary to make adjustment, see Section 5, paragraph 5.5a.

7. TERMINALS:

GND, J109 - a binding post connected directly to the chassis of the instrument.

DC, J108 - a binding post to be used when it is desired to have the response of the

scope proportional to the DC voltage being observed.

AC, J107 - a binding post to be used where it is desired to neglect the DC component of the AC voltage being observed.

DC, J110 - a binding post to be used in conjunction with the other DC binding post for un-attenuated double ended input. Under normal single ended operation this binding post should be shorted to the GND binding post.

INTENSITY MOD., J111 - a binding post permitting the Z axis or intensity of the beam to be modulated by application of an external voltage to this binding post.

c. HORIZONTAL CONTROLS

1. HORIZONTAL SELECTOR, S101: a control of the horizontal sweep of the electron beam. There are five positions available:

(a) HOR. AMP. X1: the input signal is fed directly to the cathode follower and horizontal amplifier.

(b) HOR. AMP. X10: the input signal is attenuated to 1/10th of its normal value.

(c) LINE: the horizontal sweep is of the wave form and frequency of the AC power supply (usually a 60 cycle sine wave).

(d) RECURRENT SWEEP: the horizontal sweep is obtained from the internal sweep circuit oscillator and may be of any frequency from 2 cycles to 30 kc. The output of the sweep circuit oscillator is of a sawtooth wave form. With such a sweep, the beam progresses from left to right at a constant rate and returns to the left side almost instantaneously to start the next sweep.

(e) DRIVEN SWEEP: the same range of frequencies as provided for recurrent sweep are available for the DRIVEN SWEEP. However, the sweep will not be triggered until the voltage is applied to the vertical input when the sync. selector is in the INT. position or until the voltage is applied to the ext. sync. connector when the sync. selector is in the EXT. position.

2. HORIZONTAL GAIN, R111: a vernier control of the input voltages applied to the horizontal amplifier and, subsequently, to the horizontal plates of the cathode ray tube.

3. HORIZONTAL POSITIONING, R117, Left-Right: a control of the horizontal position of the cathode ray pattern.

4. PHASING, R105: this control is effective only when the HORIZONTAL SELECTOR is in the LINE position. It is used to adjust the phase of the line frequency signal applied to the horizontal amplifier.

5. DC BAL., R110: a control to bring the cathodes of the follower to the same potential. If necessary to make adjustment, see Section 5, paragraph 5.5a.

6. TERMINALS:

GND, J104 - direct connection to the chassis of the instrument.

DC, J102 - This terminal is connected directly to the horizontal amplifiers through the horizontal selector. This binding post is to be used when it is desired to have the response proportional to the DC voltage applied.

This binding post is also used in connection with the GND binding post for the connection of an external capacitor for reducing the sweep speed below the limits of the sweep circuit oscillator.

AC, J103 - a binding post to be used when it is desired to have the horizontal deflection proportional to the AC voltage independent of DC voltage being applied.

LINE FREQ., J106 - a terminal making available a source of line frequency voltage.

SAWTOOTH OUT., J101 - a terminal permitting internal sweep circuit oscillator voltage to be connected externally.

d. SWEEP CIRCUIT CONTROLS

1. CYCLES COARSE FREQ, S102: a control providing 9 ranges: EXT. CAP for frequencies below 2 cycles; the next 7 ranges for the coarse adjustment of the frequency of the sawtooth oscillator from 2 cycles to 30 kc; and the last 2 ranges for vertical (V) and horizontal (H) TV circuits covering the frequencies of 30 and 7875 cycles respectively. If, for some specific application, it would be convenient to have these fixed frequencies set to some other values, it is possible to re-wire the CYCLES COARSE FREQ. switch and re-adjust the fixed frequency controls, R144 and R145, so that these frequencies can be set to any frequency covered by the sweep circuit oscillator.

With the CYCLES COARSE FREQ. control turned to the EXT. CAP. position, and with an external capacitor connected between the GND and horizontal DC input binding posts, slower sweep speeds may be obtained. A paper capacitor is preferable to an electrolytic capacitor, but if sufficient capacity is not available in paper, an electrolytic can be used. When using an electrolytic capacitor, connect the negative side to the GND binding post and the positive side to the horizontal DC input binding post. When using a large

value of electrolytic capacitor for sweep speeds of 5 seconds or more the capacitor should be short-circuited after each sweep. If this is not done and it is left as a recurrent sweep, at the end of the second or third cycle linearity will be impaired and the sweep speed will gradually increase.

2. VERNIER, R143: a variable control of the frequency of the sawtooth sweep oscillator within the range covered by any one position of the CYCLES COARSE FREQ. control.

3. STABILITY CONTROL, R142: this control is a variable bias adjustment for the driven sweep limiting diode, V105A. For best operation of the sweep circuit oscillator this control should be adjusted in accordance with the following procedure.

1. Turn the oscilloscope on and allow a 15-minute warmup period.

2. Set controls as follows:

RECURRENT SWEEP

(a) Horizontal Selector - to "Recurrent" position.

(b) Locking - to zero

(c) Coarse Frequency - 50-250

(d) Sweep Vernier - full clockwise

(e) Sync Selector - Int.

(f) ADVANCE STABILITY CONTROL COMPLETELY CLOCKWISE.

(g) Horizontal Gain - about two inches sweep.

(h) No vertical input is necessary either from the calibrating voltage or from an external source.

(i) The 770 is now set up to observe wave forms using the recurrent sweep.

DRIVEN SWEEP

3. Set controls as follows for Driven Sweep.

The same procedure is followed as that previously given for recurrent sweep with the following exceptions:

(a) The Horizontal selector switch is turned to "Driven" position.

Under this condition the horizontal sweep will appear the same as in the case of recurrent sweep. With no voltage applied to the vertical, adjust the stability control gradually counter-clockwise until the Horizontal trace appears as a dot with no horizontal deflection. Apply the voltage to be observed either from the self-contained calibration voltage or from some external voltage and increase the locking control either clockwise or counter-clockwise just enough to cause horizontal deflection. If the horizontal frequency is not correct to observe the proper number of wave forms on the vertical deflection circuits, it should be adjusted approximately and then the stability control, with no vertical deflection, should be readjusted as previously described, starting with the Stability Control fully clockwise and gradually rotating in a counter-clockwise direction until the Horizontal sweep is stopped in the form of a dot.

This procedure may have to be followed when the horizontal frequency is varied from range to range, or, occasionally, from one extreme of the vernier control to the other.

4. SYNC, S105: a four position control, controlling the synchronization of the sweep circuit oscillator from INT., EXT., LINE or 2X LINE source. When turned to the INT. position, the sweep circuit oscillator may be synchronized at the frequency, or sub-multiple of the frequency, of any voltage being applied to the vertical deflecting circuits. In the LINE position, the sweep circuit oscillator can be synchronized at the internal source of line frequency. In the 2X LINE position, the sweep circuit oscillator can be synchronized from an internal source of twice line frequency.

5. LOCKING, R160: a variable control of the amount of voltage (+or -) fed to the grid of the sweep circuit oscillator tube.

6. EXT. SYNC., J105: a binding post connection to be used when synchronizing the sweep circuit oscillator from an external source of voltage. The SYNC. selector switch should be on the EXT. position.

3.3 CAUTIONS

a. NEVER turn on the oscilloscope with the case removed as very high and dangerous voltages are present.

b. DO NOT leave a spot or trace in one place for a very long period of time as it may

burn that part of the screen. When the trace is not being observed, the INTENSITY control should be adjusted until the spot disappears.

3.4 PRECAUTIONS

a. Be sure that the power supply line is 105-125 volts, 50-400 cycles, AC.

b. Be sure that the beam has been properly centered before trying to interpret patterns.

c. Set the FOCUS and INTENSITY controls for the smallest spot with the minimum readable brilliance in order to preserve the life of the tube.

d. To prevent distortion, use as little locking voltage as possible to cause the image to remain stationery.

e. Always use the maximum VERTICAL ATTENUATOR setting which will give satisfactory display.

f. The VERTICAL GAIN control is so designed that it will never reduce the vertical deflection to absolute zero. On the X1000 attenuator setting, with the VERTICAL GAIN control at zero and 100 volts AC applied, it will still give approximately .1 inch deflection.

3.5 PRELIMINARY OPERATION

a. Rotate the INTENSITY control from off. An audible click should be heard and the PILOT should light. Allow time for the cathodes to heat sufficiently for stable operation.

b. Adjust the INTENSITY control until the desired brilliance is obtained.

c. Adjust the FOCUS control until the beam becomes a point or fine line.

d. Adjust the horizontal positioning of the spot by rotating the HORIZONTAL POSITIONING control to the left or right, as required.

e. Adjust the vertical positioning of the spot by rotating the VERTICAL POSITIONING control in the up or down direction, as required.

f. The HORIZONTAL and VERTICAL GAIN controls should be advanced to give suitable deflection. These settings will vary with the application for which the oscilloscope is to be used.

g. Further settings of the controls of the Model 770 will depend upon the application made of the oscilloscope.

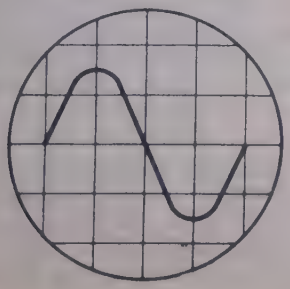
SECTION 4 - APPLICATION

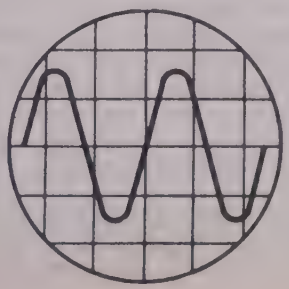
4.1 GENERAL

It is the purpose of this section to present to the reader several of the many uses of the Model 770 so as to acquaint him with proper procedures of operation and interpretation of the scope patterns. A concrete knowledge of these factors will enable the user to apply the Model 770 to the many applications not covered in this section for practical reasons. It is assumed that for the following examples, the preliminary operation as stated in Section 3 has been performed.

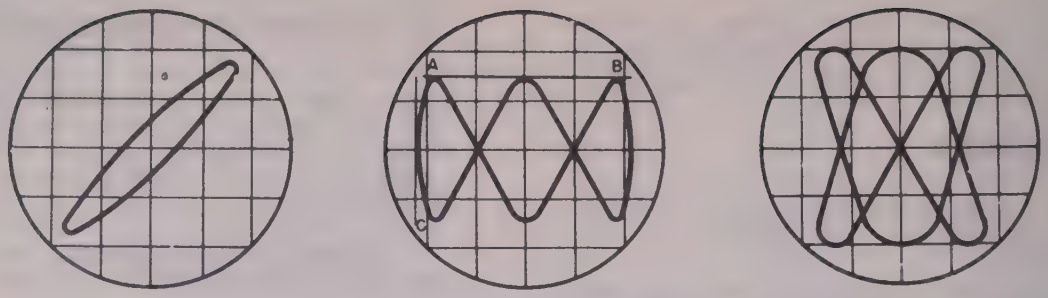
4.2 OBSERVATION OF WAVEFORMS

The voltage of the unknown waveform is applied to the vertical input AC or DC and GND binding posts, and through the vertical amplifier to the vertical deflecting plates of the cathode ray tube. The horizontal sweep for this application should be linear with respect to time, so the HORIZONTAL SELECTOR is turned to the internal sawtooth sweep oscillator or RECURRENT position. The CYCLES COARSE FREQ. and VERNIER controls are adjusted to the frequency or some submultiple of the frequency of the voltage applied to the vertical input. This condition is obtained when the scope pattern appears as a single trace of one or more cycles. The LOCKING control is advanced until the trace is perfectly still. EXAMPLE: Figure 4.1 is the trace produced when the vertical input voltage is a sine wave of a frequency of 60 cycles. The horizontal sawtooth sweep is also 60 cycles. Figure 4.2 is the trace produced when the horizontal sawtooth sweep is reduced to 30 cycles.





FIGURES 4.1 and 4.2



FIGURES 4.3, 4.4 and 4.5

This application might be used in determining hum in a power supply, distortion in amplifiers, etc.

4.3 MEASUREMENT OF PEAK-TO-PEAK VOLTAGE

To do this it is only necessary to select some voltage, either .1, 1, 10 or 100, on the Calibration Voltage peak-to-peak switch, and with the VERTICAL GAIN and VERTICAL ATTENUATOR controls adjust the vertical deflection until this voltage gives a definite vertical deflection. For example, if the calibrating voltage selected were one volt and the VERTICAL GAIN and VERTICAL ATTENUATOR controls were adjusted until one inch or 10 divisions deflection were obtained, then the scope would be calibrated so that any vertical deflection obtained when the switch was turned back to the signal being measured, the magnitude of that signal would be directly proportional to the number of inches deflection per volt. If 2.5 inches deflection were obtained, the signal would be known to have a peak-to-peak value of 2.5 volts.

The foregoing procedure will be accurate as long as the standard test leads supplied with the 770 are used. If the TVP-1 probe were being used, this would divide down the voltage being measured by a factor of approximately six times. In other words, the measured voltage should be multiplied by a factor of six to obtain the true voltage.

4.4 MEASUREMENT OF FREQUENCY USING LISSAJOU'S FIGURES

a. When voltages are applied to both horizontal and vertical deflecting plates simultaneously, a pattern is obtained, the shape of which depends upon the waveforms, frequencies and phase relationships of the applied voltages. Such patterns are called Lissajou's Figures and are useful in identifying frequencies and frequency ratios.

b. Several examples of Lissajou's Figures are illustrated in Figures 4.3, 4.4 and 4.5. Figure 4.3 illustrates sine waves applied to both sets of deflection plates with the voltages of equal frequency and 135 or 225 degrees out of phase. In Figure 4.4, the frequency of the sine wave voltage on the vertical plates is three times that on the horizontal plates. In Figure 4.5, the ratio of the frequency on the horizontal plates to that on the vertical plates is 2 to 3. Therefore, by knowing the frequency on one set of plates, the frequency of the voltage on the other set of plates can be determined. A common method of obtaining the voltage of known frequency is to use an AF of RF signal generator.

c. A study of Figure 4.4 suggests the following method of ratio identification: Note that the line AB, drawn parallel to the horizontal axis and tangent to the vertical loops, makes contact with three such loops. Also, line AC, drawn parallel to the vertical axis and tangent to the horizontal loops, contacts only one loop. From this, it is evident that the vertical deflecting voltage has completed three cycles in the same period of time required by the horizontal deflecting voltage to complete only one cycle. Therefore, the ratio of the frequencies must be 3 to 1.

4.5 VISUAL ALIGNMENT OF FM AND TV RECEIVERS

Since the alignment of such receivers is rather involved and the procedure varies greatly between different types of receivers, it is beyond the scope of this manual to attempt to cover this phase of the use of the Model 770. It might be stated, however, that the Model 770 has been designed especially for television alignment and is ideally suited for this work. There are two primary reasons for this, one being the fact that in the 770 the amplifiers are capable of operating as high as 5 mc and this makes it ideally suited for trouble shooting in the horizontal and vertical deflection circuits. Another reason lies in its extremely high sensitivity, .01 volts RMS per inch, which makes possible the alignment of single stages, independent of other stages when used with a television or FM alignment generator. With the advent of color television, the wide bandwidth of the vertical amplifier becomes increasingly important and necessary for observing chrominance.

SECTION 5 - MAINTENANCE

5.1 GENERAL

As the Model 770 has been built under the high standards of workmanship and quality of material of a Hickok instrument, no maintenance other than routine replacement of tubes should be necessary. It is suggested that, should the instrument need maintenance other than routine replacements, the factory be contacted in accordance with "Returning Equipment for Repair", page iv. Chassis view, Figure 5.1, and schematic wiring diagram, Figure 6.2, are included to aid in maintenance work.

CAUTION

CARE SHOULD BE TAKEN WHEN WORKING WITH THE MODEL 770 WITH THE CASE REMOVED FROM THE CHASSIS AS THERE ARE HIGH VOLTAGES PRESENT.

5.2 FUSE

The power supply is protected by a 1.5 amp. Slo-Blo fuse. This fuse should be checked if the pilot light does not light when the power is turned on. The fuse is readily accessible at the rear of the case and may be replaced without removing the chassis from the case. The B+ supply is fused with a 1/4 amp. fuse in the center tap of the plate supply winding of the transformer. The case must be removed to replace this fuse.

5.3 VACUUM TUBES

All vacuum tubes are operated at, or below, their normal ratings to insure long life and uniform service. The location of the tubes is shown in Figure 5.1. All tubes are easily accessible after the chassis has been removed from the case. To remove the chassis from the case, simply remove the two screws at the back of the case and the 10 screws around the edge of the main panel and pull the case from the chassis.

5.4 CATHODE RAY TUBE

The cathode ray tube, type 5ABP1, requires care in use and care in handling. There are four common causes of cathode ray tube failure:

(1) mechanical breakage of the glass envelope or internal parts - generally due to rough handling.

(2) burning of the screen.

(3) loss of emission of the cathode.

(4) The absence of the Post Ultor Circuit. The post ultor must be connected to either the post ultor supply or ground. Failure to do so may permanently damage the internal structure of the cathode ray tube.

Care should always be taken that the beam is not left in one spot for long periods of time as the screen may thus become burned or streaked. Adjust the beam for minimum readable brilliance and smallest spot to increase tube life.

To replace the cathode ray tube:

(1) Remove the socket from the tube.

(2) Loosen the clamp at the neck of the tube.

(3) Remove the four mounting screws holding the bezel.

(4) Pull cathode ray tube and bezel from unit.

5.5 ADJUSTMENTS

None of the following adjustments should be attempted until the oscilloscope has been operating a sufficient length of time to assure that it is at it's normal operating temperature.

a. BALANCE CONTROLS (HORIZ. & VERT.)

If either the HORIZONTAL or VERTICAL GAIN control appreciably positions the beam when operated, its associated DC BAL. control is out of adjustment. These controls are located on the front panel and are identified as R110 and R205 in the schematic wiring diagram.

If it becomes necessary to adjust these controls, the following procedure should be used:

(1) HORIZONTAL

(a) Rotate the HORIZONTAL SELECTOR switch to the amplifier position X10.

(b) Rotate the HORIZONTAL GAIN control from zero to maximum. If the beam of the cathode ray tube moves excessively from left to right or from right to left, a screw driver should be inserted in the slot of the horizontal DC BAL. potentiometer, adjusting it until the beam movement is at a minimum with rotation of the HORIZONTAL GAIN control.

(2) VERTICAL

(a) Set the VERTICAL ATTENUATOR to the X1000 position.

(b) Rotate the VERTICAL GAIN control from zero to maximum. If the beam of the cathode ray tube moves excessively from top to bottom, or vice versa, a screw driver should be inserted in the slot of the vertical DC BAL. potentiometer, adjusting it until the beam movement is at a minimum with rotation of the VERTICAL GAIN control.

b. CALIBRATION CONTROLS - VERTICAL AMPLIFIER

(1) BIAS, R211 - INPUT AMPLIFIER, V109: This control is adjusted so that the input amplifier is operating at approximately 0.3 volts bias.

(2) VERT. CENTERING, R214: This control is adjusted so that when the vertical positioning control, R218, is mechanically centered, the beam is centered vertically.

(3) BIAS, R224 - TRANSITION AMPLIFIER, V110: This control is adjusted so that the transition amplifier is operating at approximately 0.5 volts bias.

(4) BAL., R232 - INTERMEDIATE CATHODE FOLLOWER, V111: This control is adjusted so that when the grids of the intermediate cathode follower are shorted together, there is no voltage difference between the cathodes.

(5) TRIMMER CONDENSERS: Trimmer Condensers C147, C148, C149, C150, C151, and C152 are adjusted for proper frequency response in the wide position of the Band Width switch.

c. CALIBRATION CONTROLS - HORIZONTAL AMPLIFIER

(1) ZERO GAIN ADJUST, R114: This control is adjusted for minimum horizontal deflection when the horizontal gain control is at zero and the horizontal selector on "Recurrent" position.

(2) HORIZ. CENTERING, R115: This control is adjusted so that when the horizontal positioning control, R117, is mechanically centered, the beam is centered horizontally.

(3) BIAS, R122 - INPUT AMPLIFIER, V102: This control is adjusted so that the input amplifier is operated at approximately 0.7 volts bias.

(4) BIAS, R128 - OUTPUT AMPLIFIER, V103: This control is adjusted so that the output amplifier is operated at approximately 3.5 volts bias.

(5) HORIZ. LINEARITY, R131: This control is adjusted for maximum horizontal linearity.

(6) TRIMMER CONDENSERS: Trimmer condensers C109 and C110 are adjusted for proper frequency response.

d. CALIBRATION CONTROLS - SWEEP CIRCUIT

(1) LOW FREQ. ADJ., R151: This control is adjusted so that the sweep circuit oscillator produces frequencies within the specified ranges of the Coarse Frequency switch.

(2) SWEEP DC. LEVEL, R139: This control is adjusted so that the horizontal sweep expands equally in both directions.

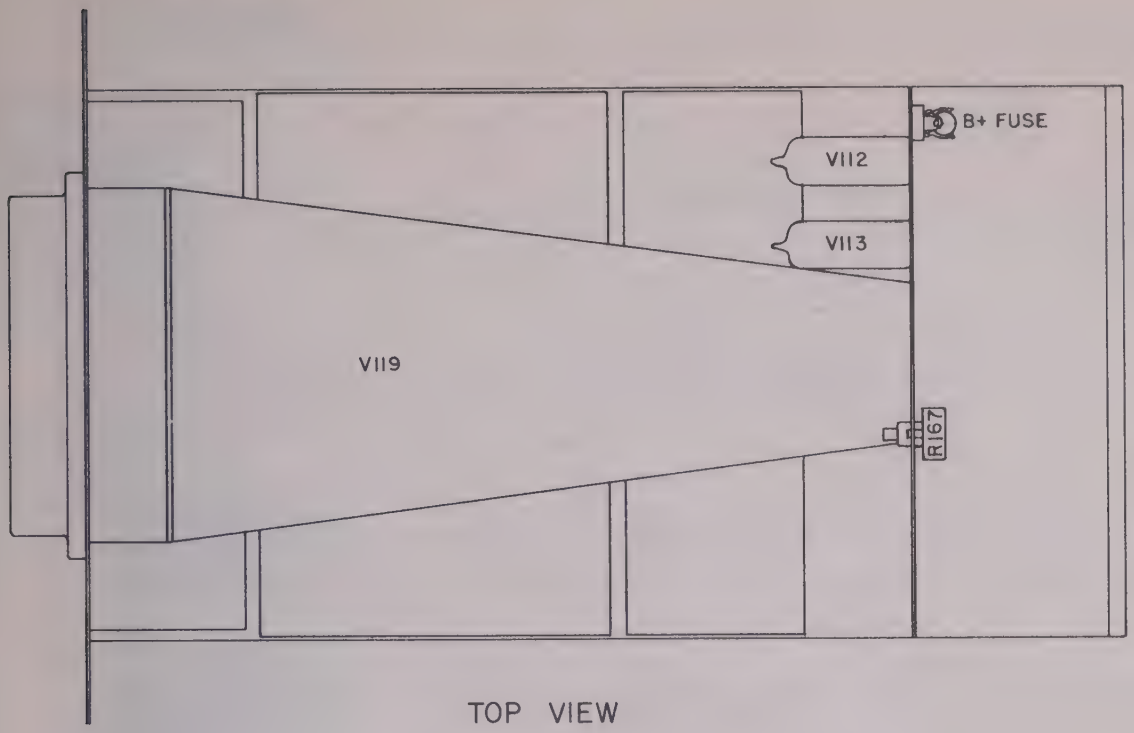
(3) 30 CYCLE FIXED FREQUENCY ADJUSTMENT, R144: This control is adjusted for 30 cycle sweep when the Coarse Frequency switch is in the V-TV position with the locking control at zero.

(4) 7875 CYCLE FIXED FREQUENCY ADJUSTMENT, R145: This control is adjusted for 7875 cycle sweep when the Coarse Frequency switch is in the H-TV position with the locking control at zero.

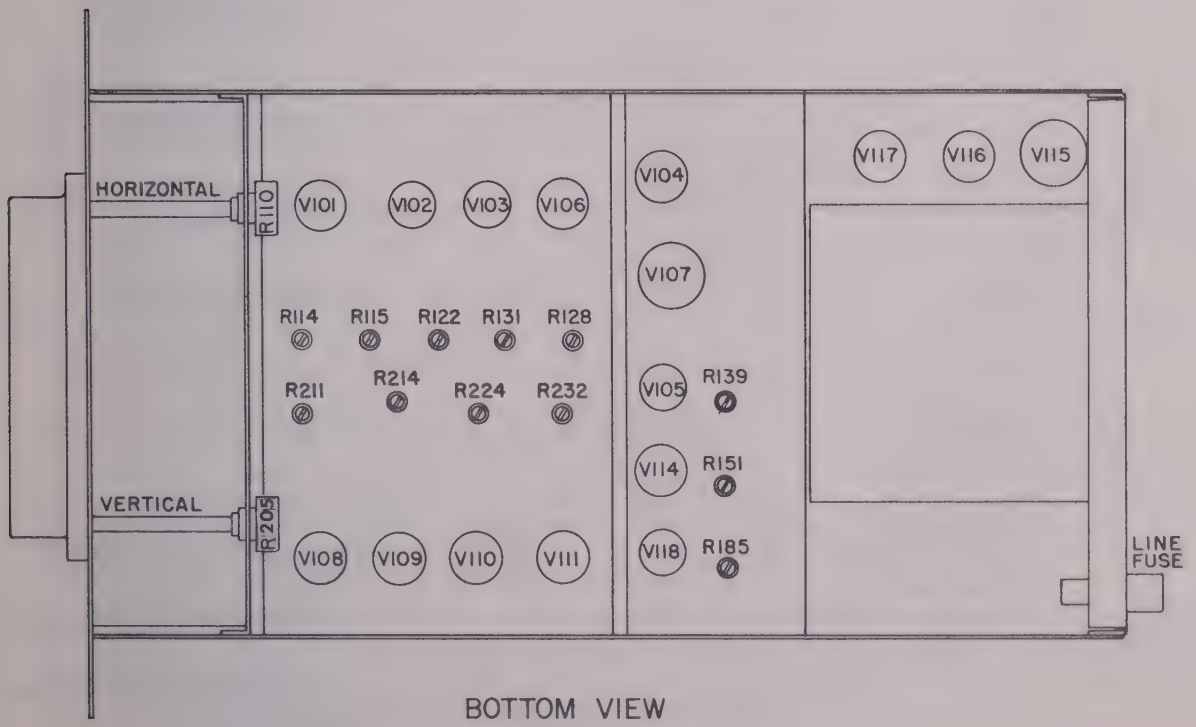
e. CALIBRATION CONTROLS - MISCELLANEOUS

(1) VOLTAGE CAL. ADJ., R185: This control is adjusted so that the voltage fed to the voltage calibrator switch is 100 volts peak-to-peak when the line voltage is 115 volts.

(2) ASTIGMATISM, R167: This control is adjusted so that the voltage at the astigmatic grid of the cathode ray tube, V119, is equal to the average of the vertical and horizontal deflection plate voltages. A maladjustment of this control will cause de-focusing of the trace as it is positioned from the center of the cathode ray tube.



TOP VIEW



BOTTOM VIEW

FIGURE 5.1 - CHASSIS VIEW, MODEL 770

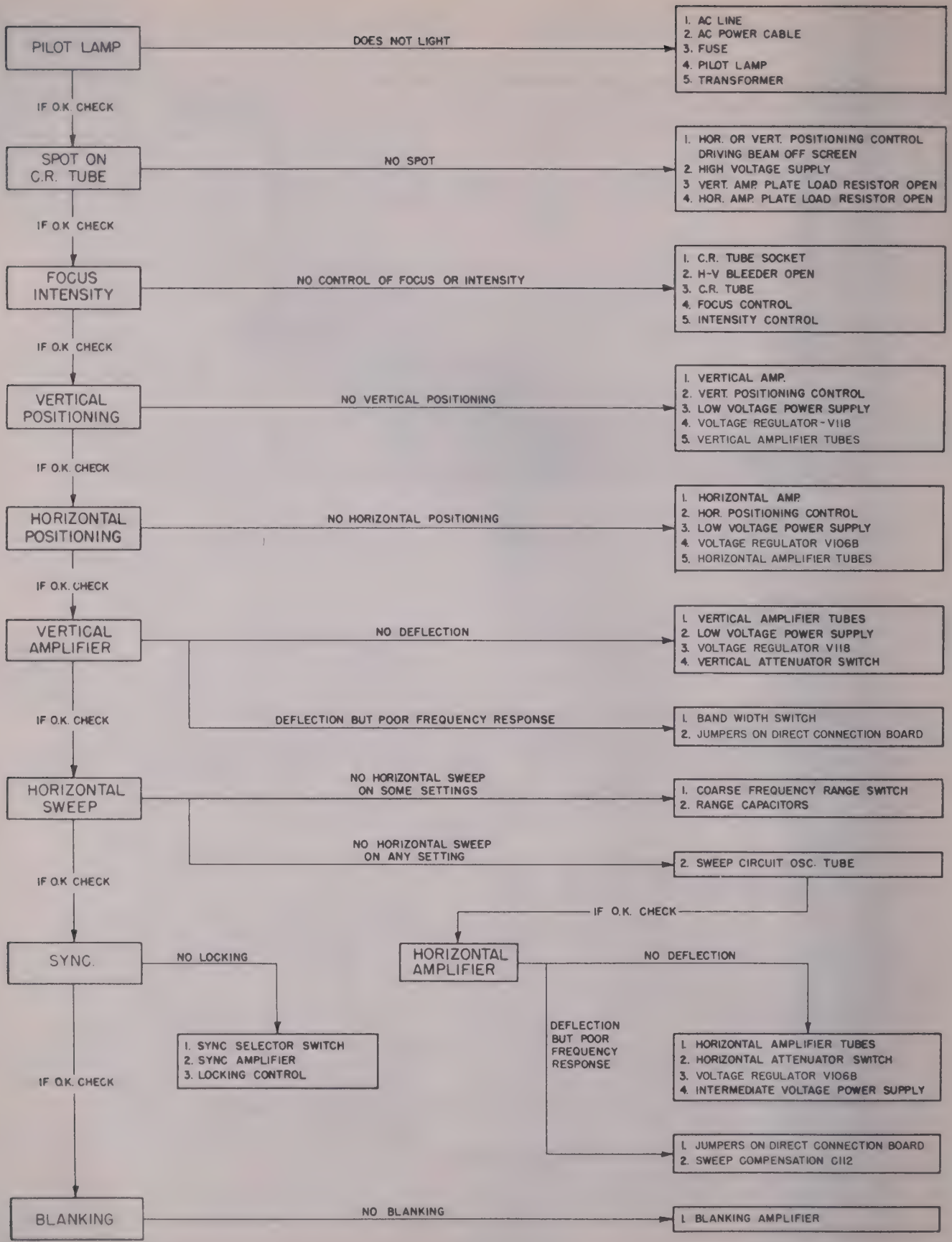


FIGURE 5.2 - TROUBLE SHOOTING CHART

TUBE	TYPE & FUNCTION	PIN NO										
		1	2	3	4	5	6	7	8	9	10	11
V101	12AU7 HORIZONTAL INPUT CATHODE FOLLOWER	350V 29.7-39.7K	0 2.2M	20.3V 4.7-14.7K	3.15VAC 50VDC 56K	3.15VAC 50VDC 56K	350V 29.7-39.7K	0 0	20.3V 8.4K	3.15VAC 50VDC 56K		
V102	6J6 HORIZONTAL INPUT AMPLIFIER	66V 53K	66V 53K	3.15VAC 50VDC 56K	3.15VAC 50VDC 56K	20.3V 6.8-17.8K	20.3V 4.7 14.7K	21V 47-50K				
V103	6J6 HORIZONTAL OUTPUT AMPL FIER	220V 88.5K	220V 88.5K	3.15VAC 50VDC 56K	3.15VAC 50VDC 56K	66V 53K	66V 53K	69.5V 10-15K				
V104	12AU7 BLANK AMPLIFIER SWEEP CATHODE FOLLOWER	51V 125K	-15V 15K	0 0	3.15VAC 50VDC 56K	3.15VAC 50VDC 56K	370V 40K	50V 240K 290K	73V 220K	3.15VAC 50VDC 56K		
V105	6AL5 DRIVEN SWEEP CLAMPER & SYNC LIMITER	0 1K **	55V 240K 290K	3.15VAC 50VDC 56K	3.15VAC 50VDC 56K	100V 0-50K	0 0	-.5V 100K				
V106	12AU7 REGULATOR INT. SYNC AMPLIFIER	205V 125K	99V 20K	105V 8.2K	3.15VAC 50VDC 56K	3.15VAC 50VDC 56K	380V 25K	68V 130K	83V 43K	3.15VAC 50VDC 56K		
V107	884 SWEEP DISCHARGE		3.15VAC 50VDC 56K	54 240K 290K		-.4V 115K		3.15VAC 50VDC 56K	10V 1-4K*			
V108	12AU7 VERTICAL INPUT CATHODE FOLLOWER	105V 8.2K	0 2.2M	4.3V 2.2K	3.15VAC 50VDC 56K	3.15VAC 50VDC 56K	105V 8.2K	0 2.2M	4.3V 2.2K	3.15VAC 50VDC 56K		
V109	12BH7 VERTICAL INPUT AMPLIFIER	57V 9.5K	4.3V 2.2K	4.6V 0-500 ∿	3.15VAC 50VDC 56K	3.15VAC 50VDC 56K	57V 9.5K	4.3V 2.2K	4.6V 0-500 ∿	3.15VAC 50VDC 56K		
V110	12AV7 TRANSITION AMPLIFIER	96V 10K	57V 9.5K	57.5V 17.6K	3.15VAC 50VDC 56K	3.15VAC 50VDC 56K	96V 10K	57V 9.5K	57.5V 176K	3.15VAC 50VDC 56K		
V111	12AV7 CATHODE FOLLOWER (INTERMEDIATE)	380V 25K	96V 10K	103V 13.2K	3.15VAC 50VDC 56K	3.15VAC 50VDC 56K	380V 25K	96V 10K	103V 13.2K	3.15VAC 50VDC 56K		
V112	6CL6 VERTICAL OUT AMPLIFIER	105V 8.3K	103V 13.2K	225V 40K	3.15VAC 50VDC 56K	3.15VAC 50VDC 56K	265V 30K	105V 8.3K	225V 40K	103V 13.2		
V113	6CL6 VERTICAL OUT AMPLIFIER	105V 8.3K	103V 13.2K	225V 40K	3.15VAC 50VDC 56K	3.15VAC 50VDC 56K	265V 30K	105V 8.3K	225V 40K	103V 13.2K		
V114	12AU7 SYNC AMPLIFIER PHASE SPLITTER	21V 110K	0 0-200K	.8V 10K	3.15VAC 50VDC 56K	3.15VAC 50VDC 56K	100V 110K	2.4V 2.2M	14.5V 1.8K	3.15VAC 50VDC 56K		
V115	5Y3 LOW VOLT. RECTIFIER		380V 25.2K		400VAC 3K		400VAC 3K		380V 25.2K			
V116	1X2B*** HIGH VOLT. RECTIFIER	1300VAC 260K	1300VAC 260K		1300VAC 260K	1300VAC 260K	1300VAC 260K		1300VAC 260K	1300VAC 260K	PLATE -1500V. 1.2M	
V117	1X2B*** HIGH VOLT. RECTIFIER	+1600V 10M	+1600V 10M		+1600V 10M	+1600V 10M	+1600V 10M		+1600V 10M	+1600V 10M	1300VAC 260K	
V118	0B2 REGULATOR	101-105V 7.2K	0 0			101-105V 7.2K		0 0				
	PIN NO.	1	2	3	5	7	8	9	10	11	14	POST ULTOR
V119	5ABP1**** CATHODE RAY TUBE	-1325V 1.2M	-1250V 1.2M	-1300V 1.5M	-850V 1.0M	+265V 30K	+265V 30K	+275V 75-175K	+220V 88.5K	+220V 88.5K	-1325V 1.2M	+1600V 10M

* WHEN SWEEP IS DRIVEN R=1-4K WHEN SWEEP IS RE-CURRENT 0-3K
** WHEN SWEEP IS DRIVEN R=1K WHEN SWEEP IS RE-CURRENT R=0 ∿
*** 1.25VAC BETWEEN PINS 1, 4, 6, 9 AND 2, 5, 8
**** 6.3VAC BETWEEN PINS 1-14
ALL VOLTAGES MEASURED WITH VACUUM TUBE VOLT METER FROM GROUND
ALL RESISTANCES MEASURED WITH OHM METER FROM GROUND

FIGURE 5.3 - VACUUM TUBE VOLTAGE AND RESISTANCE DATA CHART

TO ALL USERS OF COMMUNICATION EQUIPMENT:

We quite frequently get inquiries from servicemen who are either starting in radio servicing or are interested in knowing what additional equipment they should purchase in connection with their service work. I am, therefore, briefly summarizing the suggested equipment for servicing various types of radio and television receivers.

The basic instruments, of course, are a tube tester, volt-ohm-milliammeter, vacuum tube voltmeter and signal generator of one type or another. In addition to the foregoing, we might break down their requirements as follows:

1. AM RECEIVERS - The basic requirements as outlined above could conceivably be the minimum requirements for servicing AM receivers.

2. FM RECEIVERS - In addition to the above, the signal generators should be capable of supplying a frequency modulated signal and our Model 288X Signal Generator, 610A Signal Generator or 695 Signal Generator would be considered entirely satisfactory. In addition to this, an oscilloscope would be required. Any of our oscilloscopes such as the Model 665, 670, 770 or 385 would be equally satisfactory.

3. MOBILE COMMUNICATION RECEIVERS - These units, which operate in the 42 or the 152 megacycle band, should have a signal generator such as our Model 292X or 292X-AL for this band. The reason for this selection of such a signal generator is that such receivers have to have a generator capable of attenuating down to a fraction of a microvolt for checking the squelch region.

4. BLACK AND WHITE TELEVISION RECEIVERS - A sweep generator such as our Model 610A will be satisfactory for alignment of receivers and with its self-contained markers will be suitable for the accurate alignment of I.F. amplifiers as the marker frequency range, self-contained in the 610A, covers all frequencies currently being used in I.F. stages. For alignment of the front end of the television receiver a crystal can be obtained for sound frequency which will permit the alignment of the local oscillator in the front end. If it is desired to view the response characteristics of the front end, a marker generator should be obtained such as our Model 690. While it is true that many standard signal generators on the market today could be used as a marker oscillator, providing they have proper frequency coverage - namely from 50 to 216 megacycles, the ordinary oscillator is probably not accurate to much better than 1% and 1% at 216 megacycles presupposes a potential error of over 2 megacycles which is not too good in connection with accurate alignment.

More recent additions to our line are the Model 690 Marker Calibrator and Model 691 Heterodyned Marker Adder, which permits markers to be placed on the response curve independent of traps as well as placing markers on the base line. Our Model 695 VHF-FM Signal Generator does not contain markers, but does provide for a sweep signal with electronic frequency modulation. This Signal Generator also provides a meter bias volts for pre-setting any AGC voltage as outlined in the television receiver manufacturer's operating instructions. This signal generator also provides for blanking, giving a base line reference for response curve when making visual alignments.

The Model 650C Video Generator is very essential for trouble-shooting in television receivers as well as the alignment of horizontal and vertical linearity.

5. COLOR TELEVISION - In addition to the requirements for black and white television, the color television test equipments should include the 650C Video Generator, white dot generator for use in connection with convergence alignment of 3 gun television tubes.

The Model 655XC Color Bar Generator, which generates the standard NTSC signal, is also a definite requirement for servicing a color television receiver. Also in color television receivers there is on the back porch following the horizontal sync. pulse a color burst frequency of approximately 3.58 megacycles and in order to properly observe this color burst frequency, a cathode ray oscilloscope must be used which is capable of reproducing 3.58 megacycles. The Model 770 scope is satisfactory for this as well as our new Model 385.

We will shortly announce a combination TV Alignment Marker Generator which is designed for use in connection with both black and white and color receivers.

Very truly yours

THE HICKOK ELECTRICAL INSTRUMENT COMPANY

W. A. Weiss
Vice-President, Engineering

PARTS LIST FOR MODEL 770

NOTE: There is a minimum billing charge of $1.50 for any one parts order. Prices will be furnished upon request.

SYMBOL REF.	HICKOK CODE NO.	NAME AND DESCRIPTION	FUNCTION
J101 thru J111	2360-46	BINDING POST: #DF30BC, black	
	3030-58	CABLE, ASS'Y: 48"	
C101	3105-208	CAPACITOR: .1 mfd, 1000 volts, paper	
C102	3115-1	CAPACITOR: 3-12 mfd, trimmer	
C103	3110-21	CAPACITOR: 100 mmf, 500 volt, ceramic	
C104	3105-210	CAPACITOR: .1 mfd, 200 volts, paper	
C105	3105-204	CAPACITOR: 1 mfd, 200 volts, paper	
C106	3085-48	CAPACITOR: 25 mfd, 50 volt, electrolytic	
C107	3110-7	CAPACITOR: 5000 mmf, 500 volts, ceramic	
C108	3110-12	CAPACITOR: 1000 mmf, 500 volt, ceramic	
C109	3115-7	CAPACITOR: 1-3.5 mmf, trimmer	
C110		CAPACITOR: Same as C109	
C111		CAPACITOR: Same as C103	
C112		CAPACITOR: Same as C102	
C113		CAPACITOR: Same as C106	
C114	3105-206	CAPACITOR: .5 mfd, 200 volts, paper	
C115		CAPACITOR: Same as C114	
C116	3105-212	CAPACITOR: .04 mfd, 200 volt, paper	
C117	3110-19	CAPACITOR: 6800 mmf, 500 volts, ceramic	
C118		CAPACITOR: Same as C108	
C119	3110-38	CAPACITOR: 220 mmf, 500 volts, ceramic	
C120		CAPACITOR: Same as C119	
C121	3105-205	CAPACITOR: .01 mfd, 400 volts, paper	
C122	3105-211	CAPACITOR: .05 mfd, 600 volts, paper	
C123		CAPACITOR: Same as C105	
C124		CAPACITOR: Same as C105	
C125		CAPACITOR: Same as C105	
C126		CAPACITOR: Same as C121	
C127		CAPACITOR: Same as C121	
C128	3105-140	CAPACITOR: .05 mfd, 2000 volts, paper	
C129		CAPACITOR: Same as C128	
C130	3105-209	CAPACITOR: .1 mfd, 400 volts, paper	
C131		CAPACITOR: Same as C130	
C132		CAPACITOR: Same as C130	
C133		CAPACITOR: Same as C130	
C134		CAPACITOR: Same as C104	
C135	3105-142	CAPACITOR: .5 mfd, 2000 volts, paper, plastic ins., oil impreg. special mtg. bracket	
C136		CAPACITOR: Same as C135	
C137		CAPACITOR: Same as C135	
C138	3085-38	CAPACITOR: 20-20-20-20 mfd, 450 volt, electrolytic	
C139		CAPACITOR: Same as C138	
C140		CAPACITOR: Same as C101	
C141		CAPACITOR: Same as C102	
C142		CAPACITOR: Same as C103	
C143		CAPACITOR: Same as C102	
C144		CAPACITOR: Same as C108	
C145		CAPACITOR: Same as C102	
C146		CAPACITOR: Same as C121	
C147	3115-1	CAPACITOR: 3-12 mmf, trimmers	
C148		CAPACITOR: Same as C147	
C149		CAPACITOR: Same as C147	
C150		CAPACITOR: Same as C147	
C151		CAPACITOR: Same as C147	
C152		CAPACITOR: Same as C147	
C153	3095-66	CAPACITOR: 680 mmf, mica, 10%, 500 V	
C154		CAPACITOR: Same as C104	

PARTS LIST FOR MODEL 770

NOTE: There is a minimum billing charge of $1.50 for any one parts order. Prices will be furnished upon request.

SYMBOL REF.	HICKOK CODE NO.	NAME AND DESCRIPTION	FUNCTION
C155	3095-8	CAPACITOR: 470 mmf, 500 volt, mica, 10%	
C156		CAPACITOR: Same as C107	
L101	3250-33	CHOKE: 125 mil., Power Filter	
F101	6900-9	FUSE: 1-1/2 amp, Slo-Blo, 3 AG	
F102	6900-20	FUSE: 1/4 amp	
	11500-11	KNOB, ASS'Y: bar knob with pointer	
	11505-46	KNOB: Machines, with white dot	
	11505-68	KNOB	
	11505-72	KNOB	
N101	12270-26	LAMP: Neon, NE2	VOLTAGE REGULATOR
I101	12270-12	LAMP: #47 G.E., 6-8 volts, 15 amps, miniature bayonet base	PILOT
I102 thru I105	12270-22	LAMP: #51 G.E.	SCALE ILLUMINATION
	12450-225	LEAD, ASS'Y: 48"	
R101	18415-221	RESISTOR: 2.2 meg, 5%, 1/2 W	
R102	18414-221	RESISTOR: 220 K, 5%, 1/2 W	
R103	18415-222	RESISTOR: 2.2 meg, 10%, 1/2 W	
R104	18415-102	RESISTOR: 1 meg, 10%, 1/2 W	
R105	16925-217	POTENTIOMETER: 100 K, 20%, 1/2 W, carbon	PHASING
R106		RESISTOR: Same as R103	
R107	18413-472	RESISTOR: 47 K, 10%, 1/2 W	
R108	18410-472	RESISTOR: 47 ohm, 10%, 1/2 W	
R109	18412-472	RESISTOR: 4.7 K, 10%, 1/2 W	
R110	16925-219	POTENTIOMETER: 10 K, 20%, 1/2 W, linear, carbon	HORIZ. D.C. BALANCE
R111	16925-220	POTENTIOMETER: 25 K, 20%, 1/2 W, linear, carbon	HORIZ. GAIN
R112	18412-182	RESISTOR: 1.8 K, 10%, 1/2 W	
R113		RESISTOR: Same as R109	
R114	16925-221	POTENTIOMETER: 10 K, 20%, 1/2 W, linear, carbon	HORIZ. ZERO GAIN ADJUST
R115	16925-222	POTENTIOMETER: 1 K, 20%, 1/2 W, linear, carbon	HORIZ. CENTERING ADJUST
R116	18412-681	RESISTOR: 6.8 K, 5%, 1/2 W	
R117	16925-227	POTENTIOMETER: 10 K, 20%, 1/2 W, linear, carbon	HORIZ. POS.
R118	18424-822	RESISTOR: 820 K, 10%, 1 W	
R119		RESISTOR: Same as R108	
R120		RESISTOR: Same as R108	
R121		RESISTOR: Same as R109	
R122	16925-218	POTENTIOMETER: 3 K, 20%, 1/2 W, linear, carbon	HORIZ. DRIVER BIAS
R123	18413-101	RESISTOR: 10 K, 5%, 1/2 W	
R124		RESISTOR: Same as R123	
R125		RESISTOR: Same as R108	
R126		RESISTOR: Same as R108	
R127	18423-102	RESISTOR: 10 K, 10%, 1 W	
R128	16925-223	POTENTIOMETER: 5 K, 20%, 1/2 W, linear, carbon	HORIZ. FINAL BIAS
R129	18433-511	RESISTOR: 51 K, 5%, 2 W	
R130		RESISTOR: Same as R129	
R131	16925-224	POTENTIOMETER: 25 K, 20%, 2 W, linear, carbon	HORIZ. LINEARITY
R132	18434-102	RESISTOR: 100 K, 10%, 2 W	
R133	18413-152	RESISTOR: 15 K, 10%, 1/2 W	
R134	18414-681	RESISTOR: 680 K, 5%, 1/2 W	
R135	18414-151	RESISTOR: 150 K, 5%, 1/2 W	
R136	18423-431	RESISTOR: 43 K, 5%, 1 W	
R137	18414-222	RESISTOR: 220 K, 10%, 1/2 W	
R138		RESISTOR: Same as R104	

PARTS LIST FOR MODEL 770

NOTE: There is a minimum billing charge of $1.50 for any one parts order. Prices will be furnished upon request.

SYMBOL REF.	HICKOK CODE NO.	NAME AND DESCRIPTION	FUNCTION
R139	16925-210	POTENTIOMETER: 25 K, 20%, 1/2 W, linear, carbon	SWEEP D.C. LEVEL ADJ.
R140	18413-102	RESISTOR: 10 K, 10%, 1/2 W	
R141		RESISTOR: Same as R132	
R142	16925-211	POTENTIOMETER: 50 K, 20%, 1/2 W, linear, carbon	SWEEP STABILITY
R143	16925-212	POTENTIOMETER: 250 K, 20%, 1/2 W, linear, carbon	SWEEP VERNIER
R144	16925-213	POTENTIOMETER: 250 K, 20%, 1/2 W, linear, carbon	30 CYCLE, TV FREQ.
R145		POTENTIOMETER: Same as R144	7875 CYCLE, TV FREQ.
R146		RESISTOR: Same as R133	
R147	18413-201	RESISTOR: 20 K, 5%, 1/2 W	
R148	18411-621	RESISTOR: 620 ohms, 5%, 1/2 W	
R149	18434-101	RESISTOR: 100 K, 5%, 2 W	
R150		RESISTOR: Same as R-133	
R151	16925-218	POTENTIOMETER: 3 K, 20%, 1/2 W	LOW FREQ. SWEEP ADJ.
R152	18412-101	RESISTOR: 1 K, 5%, 1/2 W	
R153	18414-102	RESISTOR: 100 K, 10%, 1/2 W	
R154		RESISTOR: Same as R104	
R155		RESISTOR: Same as R103	
R156		RESISTOR: Same as R103	
R157		RESISTOR: Same as R112	
R158	18412-822	RESISTOR: 8.2 K, 10%, 1/2 W	
R159		RESISTOR: Same as R140	
R160	16925-214	POTENTIOMETER: 200 K, 20%, 1/2 W	SYNC. AMP. ADJ.
R161	18424-102	RESISTOR: 100 K, 10%, 1 W	
R162	18414-272	RESISTOR: 270 K, 10%, 1/2 W	
R163		RESISTOR: Same as R137	
R164		RESISTOR: Same as R112	
R165	18413-751	RESISTOR: 75 K, 5%, 1/2 W	
R166		RESISTOR: Same as R165	
R167	16925-215	POTENTIOMETER: 100 K, 20%, 1/2 W, linear, carbon	ASTIG. ADJ.
R168		RESISTOR: Same as R165	
R169	18424-561	RESISTOR: 560 K, 5%, 1 W	
R170	16925-216	POTENTIOMETER: 200 K, 20%, 1 W, linear, carbon	FOCUS ADJ.
R171	18424-332	RESISTOR: 330K, 10%, 1 W	
R172	16925-131	POTENTIOMETER: 50 K, 20%, 1 W, linear, carbon	INTENSITY CONTROL
R173		RESISTOR: Same as R133	
R174		RESISTOR: Same as R137	
R175		RESISTOR: Same as R103	
R176		RESISTOR: Same as R103	
R177		RESISTOR: Same as R103	
R178	18415-472	RESISTOR: 4.7 meg, 10%, 1/2 W	
R179		RESISTOR: Same as R178	
R180		RESISTOR: Same as R103	
R181		RESISTOR: Same as R103	
R182		RESISTOR: Same as R178	
R183		RESISTOR: Same as R178	
R184	18434-152	RESISTOR: 150 K, 10%, 2 W	
R185	16925-225	POTENTIOMETER: 50 K, 20%, 1/2 W, linear, carbon	100 VOLT PEAK-TO-PEAK ADJ.
R186	18413-471	RESISTOR: 47 K, 5%, 1/2 W	
R187	18412-471	RESISTOR: 4.7 K, 5%, 1/2 W	
R188	18411-471	RESISTOR: 470 ohm, 5%, 1/2 W	
R189	18410-511	RESISTOR: 51 ohms, 5%, 1/2 W	
R190		RESISTOR: Same as R184	
R191		RESISTOR: Same as R161	

PARTS LIST FOR MODEL 770

NOTE: There is a minimum billing charge of $1.50 for any one parts order. Prices will be furnished upon request.

SYMBOL REF.	HICKOK CODE NO.	NAME AND DESCRIPTION	FUNCTION
R192	18436-102	RESISTOR: 10 meg, 10%, 2 W	
R193		RESISTOR: Same as R104	
R194	18413-562	RESISTOR: 56K, 10%, 1/2 W	
R195	18424-332	RESISTOR: 330 K, 10%, 1 W	
R196	18413-562	RESISTOR: 56 K, 10%, 1/2 W	
R197	18410-682	RESISTOR: 68 ohms, 5%, 1/2 W	
R198		RESISTOR: Same as R101	
R199		RESISTOR: Same as R102	
R200	18413-221	RESISTOR: 22 K, 5%, 1/2 W	
R201	18412-221	RESISTOR: 2.2 K, 5%, 1/2 W	
R202	16925-226	POTENTIOMETER: 10 ohm, 20%, 2 W, wirewound	SCALE ILLUMINATION CONTROL
R203	18410-472	RESISTOR: 47 ohms, 10%, 1/2 W	
R204	18412-122	RESISTOR: 1.2 K, 10%, 1/2 W	
R205	16925-232	POTENTIOMETER: 2 K, 20%, 1/2 W, linear, carbon	VERT. DC BAL.
R206		RESISTOR: Same as R-204	
R207	16925-228	POTENTIOMETER: 10 K, 20%, 1/2 W, carbon	VERT. GAIN
R208	18411-102	RESISTOR: 100 ohm, 10%, 1/2 W	
R209		RESISTOR: Same as R203	
R210		RESISTOR: Same as R203	
R211	16925-231	POTENTIOMETER: 500 ohm, 20%, 1/2 W, linear, carbon	VERT. INPUT AMP. BIAS
R212	18413-152	RESISTOR: 15 K, 10%, 1/2 W	
R213	18432-271	RESISTOR: 2.7 K, 5%, 2 W	
R214	16925-222	POTENTIOMETER: 1 K, 10%, 1/2 W, linear, carbon	VERT. CENTERING
R215		RESISTOR: Same as R213	
R216	18413-101	RESISTOR: 10 K, 5%, 1/2 W	
R217		RESISTOR: Same as R216	
R218	16925-230	POTENTIOMETER: 5 K, 10%, 1/2 W, linear, carbon	VERT. POS.
R219		RESISTOR: Same as R203	
R220		RESISTOR: Same as R203	
R221		RESISTOR: Same as R208	
R222		RESISTOR: Same as R208	
R223		RESISTOR: Same as R109	
R224	16925-221	POTENTIOMETER: 10 K, 20%, 1/2 W, linear, carbon	TRANSITION AMP. BAAS
R225			
R226	18412-781	RESISTOR: 1.8 K, 5%, 1/2 W	
R227		RESISTOR: Same as R226	
R228		RESISTOR: Same as R203	
R229		RESISTOR: Same as R203	
R230	18433-122	RESISTOR: 12K, 2 W, 10%	
R231		RESISTOR: Same as R230	
R232	16925-229	POTENTIOMETER: 10 K, 20%, 2 W, linear, carbon	DRIVER CATHODE FOLLOWER BAL.
R233		RESISTOR: Same as R203	
R234		RESISTOR: Same as R203	
R235		RESISTOR: Same as R208	
R236		RESISTOR: Same as R208	
R237	18575-118	RESISTOR: 15 K, 10%, 5 W, wirewound	
R238	18575-142	RESISTOR: 5 K, 10%, 10 W, wirewound	
R239		RESISTOR: Same as R-238	
R240	18413-102	RESISTOR: 10 K, 10%, 1/2 W	
R241	18415-222	RESISTOR: 2.2 meg, 10%, 1/2 W	
R242		RESISTOR: Same as R203	
R243		RESISTOR: Same as R137	
R244	18424-102	RESISTOR: 100 K, 10%, 1 W	
R245	18415-222	RESISTOR: 2.2 meg, 10%, 1/2 W	
R246	16925-257	POTENTIOMETER: 200 Ohm, 20%, 2 W, carbon linear	FINAL VERT. AMP. BIAS ADJ.
R247	18411-472	RESISTOR: 470 Ohm, 1/2 W, 10%	

PARTS LIST FOR MODEL 770

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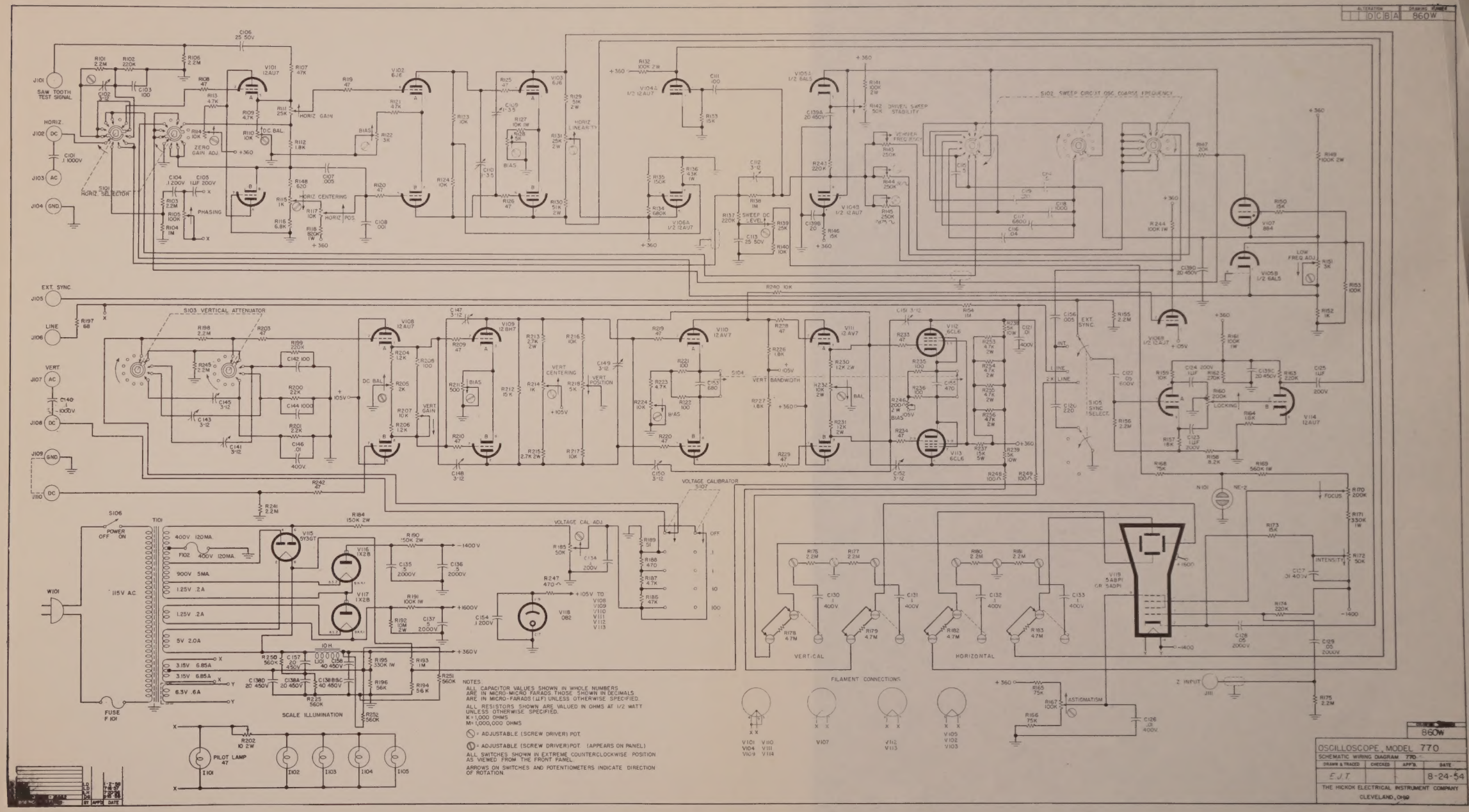
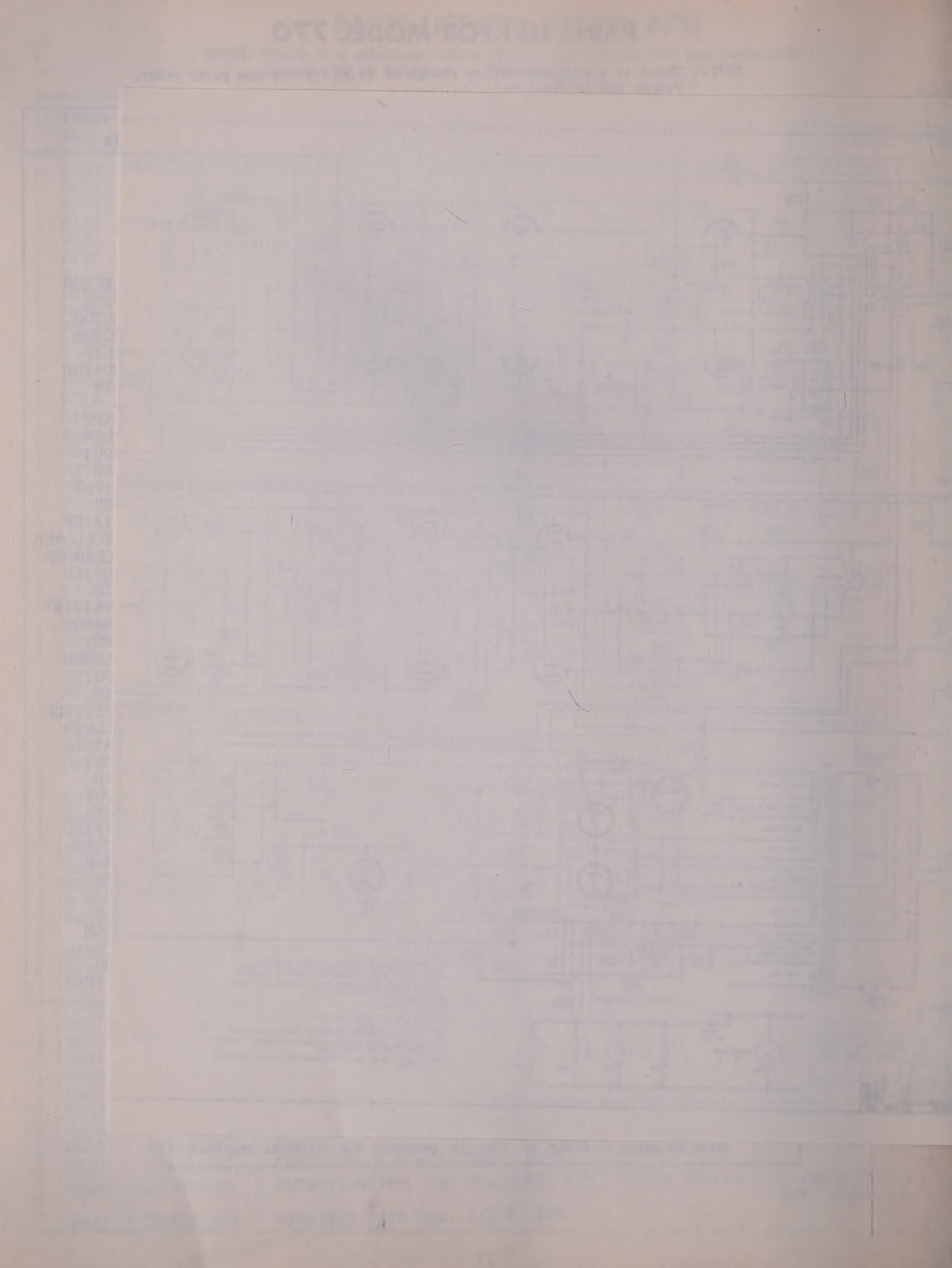
SYMBOL REF.	HICKOK CODE NO.	NAME AND DESCRIPTION	FUNCTION
R248		RESISTOR: Same as R208	
R249		RESISTOR: Same as R208	
R250	18575-157	RESISTOR: 300 Ohm, 10%, 10 W, wire wound	
	19350-30	SOCKET: octal, crimp-on	
	19350-213	SOCKET: 7-pin	
	19350-214	SOCKET: 9-pin	
S101	19912-289	SWITCH: Rotary, 4 pole, 5 position, 2 section	HORIZ. SELECTOR
S102	19912-290	SWITCH: Rotary, 3 pole, 9 position, 3 section	SWEEP COURSE FREQ. SELECTOR
S103	19912-291	SWITCH: Rotary, 2 pole, 4 position, 1 section	SYNC. SELECTOR
S104	19912-292	SWITCH: Rotary, 2 pole, 5 position, 1 section	VOLTAGE CALIB.
S105	19912-288	SWITCH: Rotary, 2 pole, 4 position, 2 section	VERT. ATTENUATOR
S106	19912-294	SWITCH: Rotary, 4 pole, 2 position, 1 section	BAND WIDTH
T101	20800-151	TRANSFORMER	POWER
V101	20875-69	TUBE: 12AU7	HORIZ. INPUT CATHODE FOLLOWER
V102	20875-71	TUBE: 6J6	HORIZ. INPUT AMPLIFIER
V103	20875-71	TUBE: 6J6	HORIZ. OUTPUT AMPLIFIER
V104	20875-69	TUBE: 12AU7	BLANK AMPLIFIER SWEEP CATHODE FOLLOWER
V105	20875-51	TUBE: 6AL5	DRIVEN SWEEP CLAMPER & SYNC. LIMITER REGULATOR
V106	20875-69	TUBE: 12AU7	INT. SYNC. AMPLIFIER
V107	20875-29	TUBE: 884	SWEEP DISCHARGE
V108	20875-69	TUBE: 12AU7	VERT. INPUT CATHODE FOLLOWER
V109	20875-124	TUBE: 12BH7	VERT. INPUT AMPLIFIER
V110	20875-116	TUBE: 12AV7	TRANSITION AMPLIFIER
V111	20875-116	TUBE: 12AV7	CATHODE FOLLOWER (INTERMEDIATE)
V112	20875-105	TUBE: 6CL6	VERT. OUTPUT AMPLIFIER
V113	20875-105	TUBE: 6CL6	VERT. OUTPUT AMPLIFIER
V114	20875-69	TUBE: 12AU7	SYNC. AMPLIFIER PHASE SPLITTER
V115	20875-6	TUBE: 5Y3GT	LOW VOLTAGE RECTIFIER
V116	20875-122	TUBE: 1X2B	HIGH VOLTAGE RECTIFIER
V117	20875-122	TUBE: 1X2B	HIGH VOLTAGE RECTIFIER
V118	20875-82	TUBE: OB2	REGULATOR
V119	20875-123	TUBE: 5ABP1	CATHODE RAY TUBE

NOTE: In ordering parts or materials for this instrument, the serial number must be given in order to identify properly the material required.


ALTERATION
D C B A
DRAWING NUMBER
860W
SAW TOOTH TEST SIGNAL
HORIZ
DC
AC
GND
HORIZ SELECTOR
ZERO GAIN ADJ
DC BAL
HORIZ GAIN
BIAS
HORIZ CENTERING
HORIZ POS.
PHASING
HORIZ LINEARITY
DRIVEN SWEEP STABILITY
VERNIER FREQUENCY
SWEEP DC LEVEL
SWEEP CIRCUIT OSC. COARSE FREQUENCY
LOW FREQ. ADJ.
EXT. SYNC.
LINE
VERT
VERTICAL ATTENUATOR
VERT CENTERING
VERT GAIN
VERT POSITION
VERT BANDWIDTH
EXT. SYNC.
INT.
LINE
2X LINE
SYNC. SELECT.
LOCKING
VOLTAGE CALIBRATOR
VOLTAGE CAL. ADJ.
POWER OFF ON
115V A.C.
FUSE F 101
SCALE ILLUMINATION
PILOT LAMP 47
FOCUS
INTENSITY
ASTIGMATISM
Z INPUT
VERTICAL
HORIZONTAL
FILAMENT CONNECTIONS
NOTES:
ALL CAPACITOR VALUES SHOWN IN WHOLE NUMBERS ARE IN MICRO-MICRO FARADS. THOSE SHOWN IN DECIMALS ARE IN MICRO-FARADS (UF) UNLESS OTHERWISE SPECIFIED.
ALL RESISTORS SHOWN ARE VALUED IN OHMS AT 1/2 WATT UNLESS OTHERWISE SPECIFIED.
K = 1,000 OHMS
M = 1,000,000 OHMS
= ADJUSTABLE (SCREW DRIVER) POT.
= ADJUSTABLE (SCREW DRIVER) POT. (APPEARS ON PANEL)
ALL SWITCHES SHOWN IN EXTREME COUNTERCLOCKWISE POSITION AS VIEWED FROM THE FRONT PANEL.
ARROWS ON SWITCHES AND POTENTIOMETERS INDICATE DIRECTION OF ROTATION.
860W
OSCILLOSCOPE, MODEL 770
SCHEMATIC WIRING DIAGRAM 770
DRAWN & TRACED
CHECKED
APP'S.
DATE
EJT
8-24-54
THE HICKOK ELECTRICAL INSTRUMENT COMPANY
CLEVELAND, OHIO



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